

ck
a master rotational frequency detector and a master phase counter for detecting simultaneously at all times a rotational frequency signal and a phase signal from an output of a rotary encoder coupled with the electric motor in the master section or from an output of a rotary encoder coupled with the machine shaft driven by said electric motor, said rotary encoder comprising an incremental encoder with a Z phase pulse, and said master phase counter operating to count the output pulses of said encoder and being cleared with said Z phase pulse;

a slave rotational frequency detector and a slave phase counter for detecting simultaneously at all times a rotational frequency signal and a phase signal from an output of a rotary encoder coupled with the electric motor in the slave section or from an output of a rotary encoder coupled with the machine shaft driven by said electric motor, said rotary encoder comprising an incremental encoder with a Z phase pulse and said slave phase counter operating to count the output pulses of said encoder and being cleared with said Z phase pulse; and

a phase deviation calculator for detecting a rotational phase deviation from the outputs of said master phase counter and said slave phase counter at all times, according to counted overflow pulses and the counted output pulses of said master phase counter and said slave phase counter, there being matched an origin of the electric motor in the master section and an origin of the electric motor in the slave section, or matched an origin of the machine shaft driven by the electric motor in the master section and an origin of the machine shaft driven by the electric motor in the slave section to achieve synchronous control.

2. (Amended) A synchronization controller including a controller of a slave section for controlling an electric motor, said synchronization controller serving to accurately synchronize a rotational frequency and rotation phase of said electric motor or a machine shaft driven by said

electric motor with a rotational frequency signal pulses and a Z phase pulse signal electronically generated within and outputted from a master section, said slave section controller comprising:

ck a master rotational frequency detector and a master phase counter for simultaneously detecting the rotational frequency signal and the phase signal from an output of an incremental encoder with a Z phase pulse coupled with the electric motor in the master section or from an output of a rotary encoder coupled with the machine shaft driven by said electric motor outputted from the master section at all times, and said master phase counter operating to count the output signal pulses from said master section and being cleared with the Z phase pulse from said master section;

a slave rotational frequency detector and a slave phase counter for detecting simultaneously at all times the rotational frequency signal and the phase signal from an output of an incremental encoder with a Z phase pulse coupled with the electric motor of the slave section or from an output of an incremental encoder with a Z phase pulse coupled with the machine shaft driven by the electric motor, and said slave phase counter operating to count the output pulses of said encoder and being cleared with said Z phase pulse; and

a phase deviation calculator for detecting a rotational phase deviation from the outputs of said master phase counter and said slave phase counter at all times, according to counted overflow pulses and the counted output pulses of said master phase counter and said slave phase counter, there being matched an origin of said electric motor of the slave section or the machine shaft driven by said electric motor based upon the phase deviation detected by said phase deviation calculator to synchronize rotation phase of said electric motor or the machine shaft driven by said electric motor with the signal outputted from the master section.

3. (Amended) A synchronization control method including a plurality of electric motors, each for driving at least one rotating machine shaft and a controller for a master section and at least one slave section, each said controller for controlling one of said electric motors, said synchronization control method serving to accurately synchronize a rotational frequency and rotation phase of each said electric motor or the machine shaft driven by each said electric motor, comprising the steps of:

when all of said electric motors start their operations from a stopped state, simultaneously detecting at all times a rotational frequency signal and a phase signal from an output of an incremental rotary encoder with a Z phase pulse coupled with the electric motor in the master section or of a machine shaft driven by said electric motor and further simultaneously detecting at all times a rotational frequency signal and a phase signal from an output of an incremental rotary encoder with a Z phase pulse coupled with of the electric motor of in the slave section or of the machine shaft driven by the said electric motor;

calculating a rotational phase deviation from said rotational frequency signal and said phase signal according to counted overflow pulses and counted output pulses of a master phase counter and a slave phase counter; and

matching origins of said electric motors of in each slave section or of the machine shafts driven by said electric motors based upon said phase deviation during acceleration of all number of the electric motors or after all number of said electric motors reach a predetermined rotational frequency, and synchronizing the rotation phase of said electric motors or of the machine shafts driven by said electric motors with the phase signal outputted from the master section.

4. (Amended) A synchronization control method including a plurality of electric

motors, each for driving at least one rotating machine shaft and a controller for each of a master section and a slave section, each controller for controlling one of said electric motors, said synchronization control method serving to accurately synchronize a rotational frequency and rotation phase of each said electric motor or the machine shaft driven by each said electric motor, comprising the steps of:

when some of said electric motors are in operation and others of said electric motors are under interruption and the operation of the electric motors under interruption is started, simultaneously detecting rotational frequency signals and phase signals from an output of an incremental rotary encoder with a Z phase pulse coupled with the electric motor in the master section or the machine shaft driven by said electric motor at all times and further simultaneously detecting the rotational frequency signals and the phase signals from an output of an incremental rotary encoder with a Z phase pulse coupled with the electric motor in each slave section or of the machine shaft driven by each said electric motor at all times;

calculating a rotational phase deviation from said rotational frequency signals and said phase signals according to counted overflow pulses and counted output pulses of a master phase counter and a slave phase counter; and

matching origins of said electric motors in each slave section or of the machine shafts driven by said electric motors based upon said phase deviation after said electric motors reach a predetermined rotational frequency to synchronize the rotation phase of said electric motors or of the machine shafts driven by said electric motors with the phase signal outputted from the master section.